4.0 COMPARISON OF ALTERNATIVES

4.1 Comparison of Plan Features

All the action alternatives would require construction of new levees to protect adjacent properties from flooding. After site preparation, construction of levees, and placement of dredged material (if applicable), the levee between the site and the bay would be graded down and breached, allowing tidal action on the site. Natural sedimentation, tidal action, and vegetation growth would then establish tidal salt marsh on the site over a period of time.

Alternatives 2 and 4 would create diverse non-tidal habitats in the panhandle area, including upland, wetland, and pond habitats. See Figure 4.1(a) and Figure 4.2. Since these alternatives would retain the panhandle portion of the HAAF parcel at or near its current grade level, an internal levee would be installed between this section and the tidal portion of the project to prevent tidal flooding. Due to the absence of a natural downhill gradient from the panhandle area to the tidal area, more maintenance and management would be needed than under Alternatives 3 and 5.

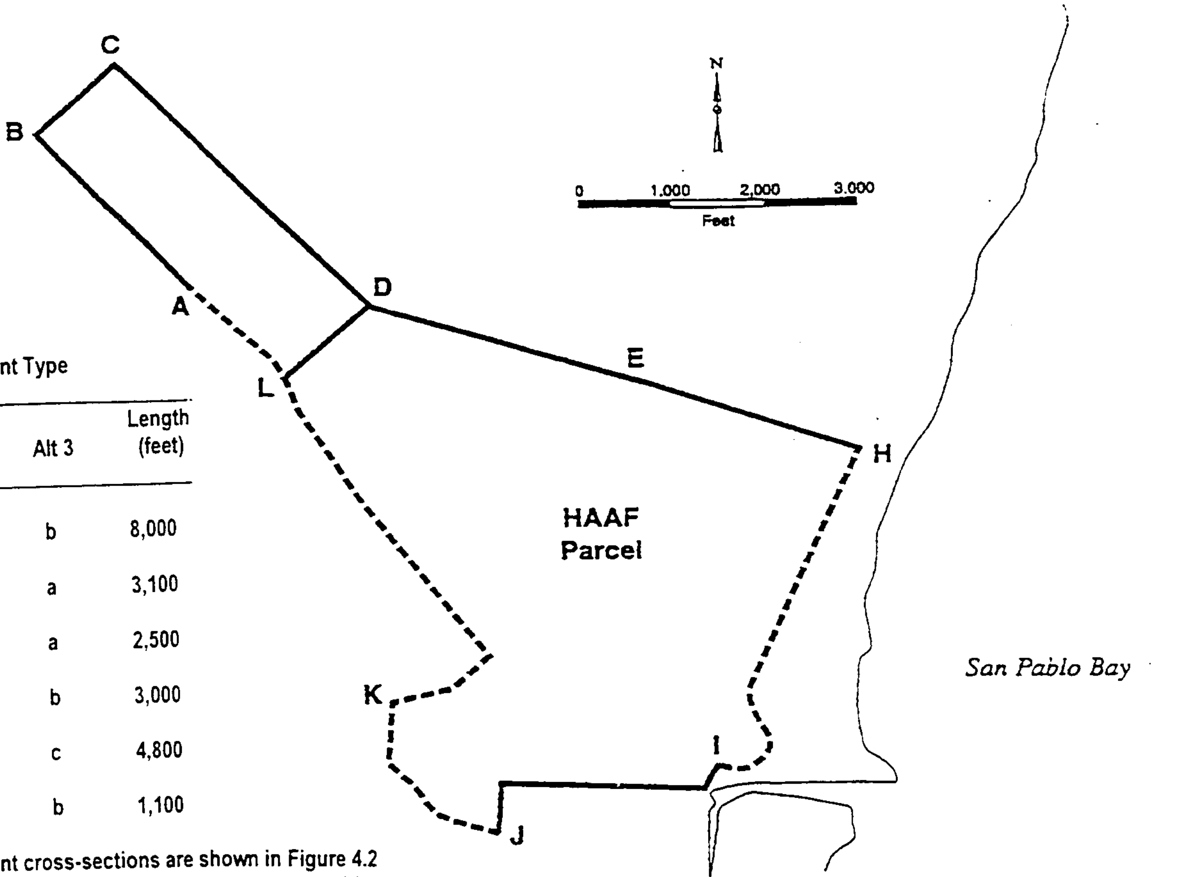
Alternatives 3 and 5 would include upland, seasonal wetland, and tidal panne habitats in the panhandle and Navy ballfield areas. These habitats would become established after the grade level is raised through emplacement of dredged material. Additional perimeter levees would be required around the panhandle to contain dredged material and avoid tidal flooding of adjacent properties. No water control structures would be required other than any required for the perimeter levees, so maintenance and management requirements associated with drainage would be minimal. See Figure 4.1(b) and Figure 4.2.

Table 4.1 compares the features of the four alternatives. Table 4.2 summarizes the costs of the four alternatives.

4.2 System of Accounts

4.2.1 Methodology

The Corps' Principles and Guidelines for the planning process have established four specific categories or "accounts" which are used to facilitate evaluation and display the effects of alternative plans. These accounts are: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). These four accounts encompass all significant effects that a plan might have on the human environment as required by the National Environmental Policy Act of 1969 (NEPA). They also encompass social well being as required by Section 122 of the Flood Control Act of 1970. Each of these resource accounts and the results of the evaluation are described below.



Segment Type

Levee Segment	Alt 2	Alt 3	Length (feet)
A-B-C-D	-	b	8,000
D-E	a	a	3,100
E-H	a	a	2,500
I-J	b	b	3,000
K-L	c	c	4,800
L-D	b	b	1,100

Notes: Levee segment cross-sections are shown in Figure 4.2
- Levee segment would not be constructed under this alternative

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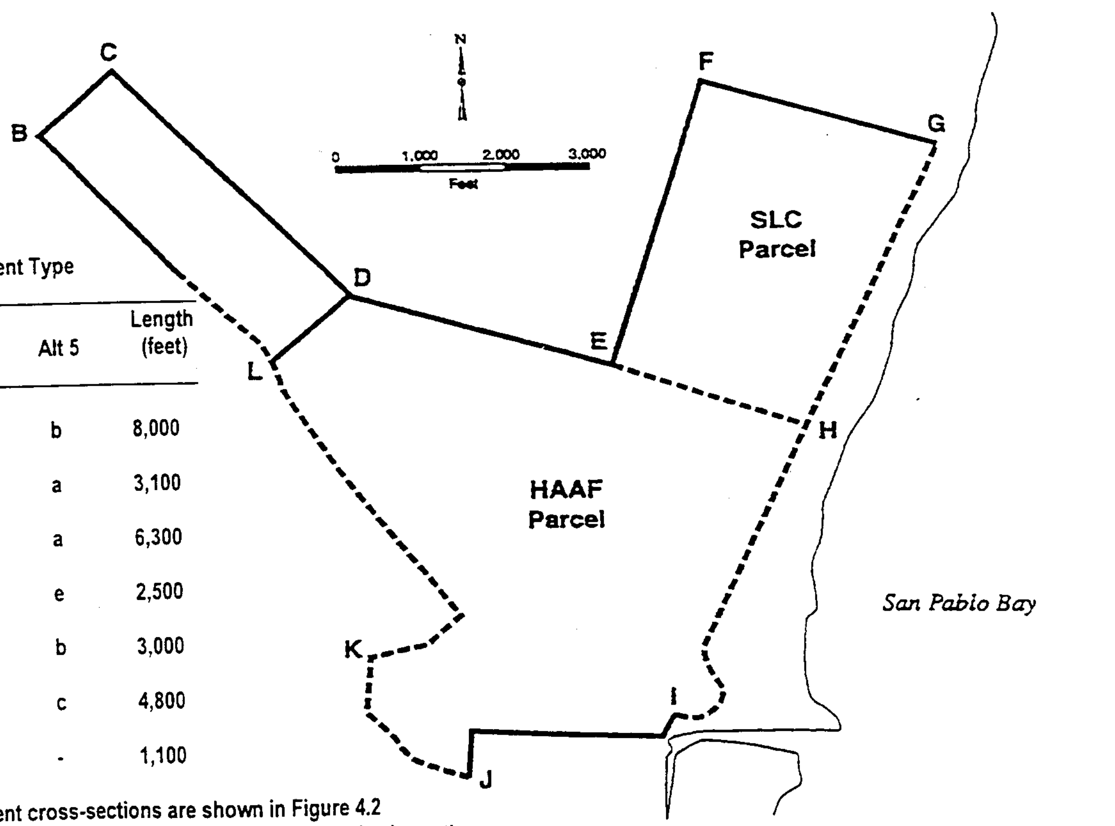
Figure 4-1a
Levee Segments for Alternatives 2 and 3



Segment Type

Levee Segment	Alt 4	Alt 5	Length (feet)
A-B-C-D	-	b	8,000
D-E	a	a	3,100
E-F-G	a	a	6,300
E-H	e	e	2,500
I-J	b	b	3,000
K-L	c	c	4,800
L-D	b	-	1,100

Notes: Levee segment cross-sections are shown in Figure 4.2
- Levee segment would not be constructed under this alternative

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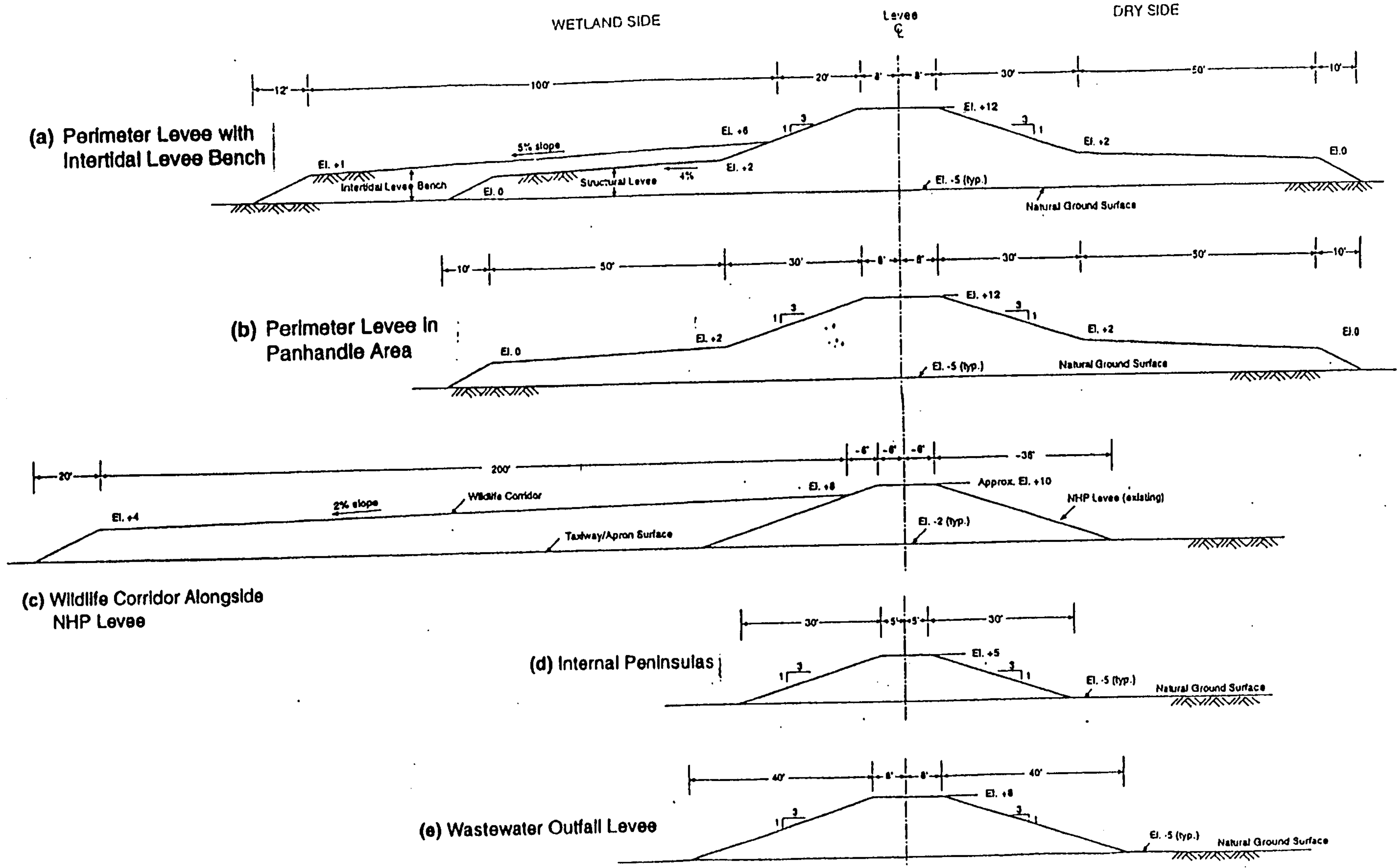
Figure 4-1b
Levee Segments for Alternatives 4 and 5



Note: End-of-construction elevations shown; final evevations will be lower.

Source: Woodward - Clyde 1998.

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Feasibility Report Figure 4.2

Typical Levee Cross Sections

Table 4.1
Comparison of Alternatives

	Alternatives			
Attributes	2	3	4	5
Acres	668	668	988	988
HAAF parcel	Yes	Yes	Yes	Yes
SLC parcel	No	No	Yes	Yes
Only natural sediment	Yes	No	Yes	No
Dredged material	No	Yes	No	Yes
New perimeter levees	9,700 ft.	16,600 ft.	13,500 ft.	20,400 ft.
New internal levees	1,070 ft.	-	1,070 ft.	-
NSD pipeline levee	2,500 ft.	2,500 ft.	2,500 ft.	2,500 ft.
Peninsula levees	5,800 ft.	5,800 ft.	5,800 ft.	5,800 ft.
Wildlife corridor	4,800 ft.	4,800 ft.	4,800 ft.	4,800 ft.
Intertidal bench	5,600 ft.	5,600 ft.	9,400 ft.	9,400 ft.
Lowered bayfront levee	3,900 ft.	3,900 ft.	7,250 ft.	7,250 ft.
Number of breaches	1	1	2	2
Relocate NSD facility	No	No	Yes	Yes
Years to complete	2	6	2	6
Total Cost	$15,046,300	$39,825,100	$20,473,100	$55,154,700

Table 4.2
Summary of Costs
(October 1998 Price Levels)

	Alt 2	**Alt 3**	**Alt 4**	**Alt 5**
Lands and Damages	$162,200	$162,200	$241,600	$241,600
Relocations	n/a	n/a	$2,138,200	$2,138,200
Levees and Floodwalls	$12,918,100	$16,926,100	$16,127,300	$20,855,800
Dredged Material Placement	n/a	$18,626,800	n/a	$27,809,100
Planning, Engineering & Design (PE & D)	$1,210,000	$1,210,000	$1,210,000	$1,210,000
Construction Management (S & A)	$756,000	$2,900,000	$756,000	$2,900,000
Total First Cost	$15,046,300	$39,825,100	$20,473,100	$55,154,700
Interest During Construction	$652,100	$5,221,800	$967,700	$7,189,300
Total Investment Cost	$15,698,400	$45,046,900	$21,440,800	$62,344,000
Average Annual Cost (@6 7/8 %)	$ 1,119,600	$ 3,212,700	$ 1,529,200	$ 4,46,300
Other OMRR &R Costs	$ 197,500	$ 233,100	$ 206,000	$ 322,000
Total Annual Cost	$ 1,317,100	$ 3,445,800	$ 1,735,200	$ 4,768,300

Alternatives 2 - 5 would result in cost savings of $400,000 per year in maintenance expenses. These savings are not reflected in the table above.

4.2.2 National Economic Development (NED)

The NED account identifies beneficial and adverse effects on the nation's economy. Beneficial effects in the NED account are increases in the economic value of the national output of goods and services from a plan. In this case, the outputs of proposed alternatives are ecosystem restoration which are quantified in non-monetary units. Therefore, a NED plan is not identified in this study.

4.2.3 Environmental Quality (EQ)

Beneficial effects in the EQ account are favorable changes in the ecological, aesthetic, and cultural attributes of the natural and cultural environment. Adverse effects in the EQ account are unfavorable changes in the ecological, aesthetic, and cultural attributes of these same resources.

Table 4.3
Summary of Environmental Quality Account

Environmental attributes	**Alternatives**				
	1	2	3	4	5
Ecological attributes (includes physical and biological aspects of ecosystems)					
Water quality	No impact	Potential positive impacts in long term	Potential positive impacts in long term	Potential larger positive impacts in long term	Potential larger positive impacts in long term
Air quality	No impact	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts
Overall wildlife Habitat value	No impact	Significant positive effect	Significant positive effect	Significant positive effect	Significant positive effect
Tidal wetland Habitat value	No impact	Moderate positive effect	Moderate positive effect	Large positive effect	Large positive effect
Seasonal Wetland habitat Value	No impact	Moderate positive effect	Large positive effect	Moderate positive effect	Large positive effect
Upland habitat Value	No impact	Moderate loss	Moderate loss	Large loss	Large loss
Cultural environment					
Cultural Resources	No impact	Potential disturbance of unknown sites	Potential disturbance of unknown sites	Potential disturbance of unknown sites	Potential disturbance of unknown sites
Aesthetic environment					
Noise	No impact	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts	Minor construction-related impacts
Visual Resources	No impact	Minor temporary impacts; long-term benefits	Minor temporary impacts; long-term benefits	Minor temporary impacts; long-term benefits	Minor temporary impacts; long-term benefits

4.2.4 Regional Economic Development (RED)

The Regional Economic Development (RED) account is intended to illustrate the effects that the study alternatives would have on regional economic activity; specifically, regional income and regional employment. The comparison of possible effects that the plans would have on these resources is shown in Table 4.4.

Table 4.4
Hamilton Wetland Restoration Feasibility Study
Regional Economic Development and Other Social Effects Account

I. Regional Economic Development	**No Action**	**Alter 2**	**Alter 3**	**Alter 4**	**Alter 5**
a. Employment/Labor Force	No change expected	24 month temporary increase in construction-related employment	6 year temporary increase in construction related employment	24 month temporary increase in construction-related employment	6 year temporary increase in construction related employment
b. Business and Industrial Activity	N/A	N/A	Potential increase in shipping efficiencies given the lack of dredging delays	N/A	Potential increase in shipping efficiencies given the lack of dredging delays
c. Local Government Finance (Oct.1998 Price Levels) State of California	N/A	Implementation cost of $3,813,550.	Implementation cost of $10,008,250.	Implementation cost of $5,150,400.	Implementation cost of $13,820,800.
II. Other Social Effects					
a. Public Health and Safety	N/A	Improved well being due to enhanced habitat	Improved well being due to enhanced habitat	Improved well being due to enhanced habitat	Improved well being due to enhanced habitat
b. Public Facilities and Services	N/A	N/A	N/A	N/A	N/A
c. Recreation and Public Access	No change expected	Increased recreational opportunities from enhanced habitat	Increased recreational opportunities from enhanced habitat	Increased recreational opportunities from enhanced habitat	Increased recreational opportunities from enhanced habitat
d. Traffic/Transportation	No change expected	No change expected	No change expected	No change expected	No change expected
e. Man Made Resources	N/A	N/A	N/A	N/A	N/A
f. Natural Resources	No change anticipated	Potential minor increase in fishing and hunting offsite	Potential minor increase in fishing and hunting offsite	Potential minor increase in fishing and hunting offsite	Potential minor increase in fishing and hunting offsite

4.2.5 Other Social Effects (OSE)

Other social effects involve urban and community impacts such as employment distribution, potential displacement of businesses, and local government's fiscal condition, as well as life, health, and safety effects. For the Hamilton Wetland Restoration Project, these impacts are not directly measurable; however, the restoration of wetlands will help improve the quality of community life for residents near the restored site and regionally.

4.3 Incremental Analysis of Project Features

4.3.1 Introduction

Purpose of the Incremental Analysis
This feasibility study examines the alternatives using a number of analyses and evaluation criteria. One analysis that must be performed is an examination of the incremental cost-efficiency of different potential measures to create fish and wildlife habitat value. In a feasibility study, this analysis is normally performed on measures that mitigate the impacts of a project on fish and wildlife habitat. In an environmental restoration feasibility study, the incremental cost analysis instead examines the cost-efficiency of the environmental restoration alternatives themselves.

In an incremental analysis, each possible combination of increments is examined for cost-efficiency. Thus, this analysis will examine the study alternatives and additional possible increments of habitat restoration. As cost-efficiency in producing fish and wildlife habitat value is only one of the criteria used to evaluate alternatives, the conclusions of this analysis are not the sole determinant of which alternatives receive detailed consideration in the feasibility study, nor which alternative is selected as the preferred plan.

The study alternatives can be broken down into two basic choices. The first choice is whether to use dredged material to accelerate the process of marsh formation. The second is which parcel(s) of land to use. These choices can be combined into eight possible increments of restoration, as described below. This section analyzes the cost-efficiency of these increments in achieving the planning objective of tidal marsh restoration. Some of these increments are not responsive to other planning objectives, but are included here for purposes of comparison.

Use of the Habitat Evaluation Procedure Results
A Habitat Evaluation Procedure (HEP) study to determine project impacts on wildlife habitat was performed by the U.S. Fish and Wildlife Service (FWS). This study looked at impacts on all habitats that either currently exist or would be created under the alternatives. In a HEP study, individual wildlife species serve as surrogates for entire habitats, with impacts on these *evaluation species* used to indicate impacts on the habitats they inhabit.

A HEP study normally fulfills two functions in a Corps feasibility study. First, it determines impacts on various wildlife habitats to determine mitigation requirements. Second, it is used by the Corps to determine the cost-effectiveness of different mitigation increments. The incremental analysis for mitigation included in a feasibility report compares the cost and output of each mitigation increment to determine the optimal level of investment in mitigation.

However, this approach has difficulties when applied to an ecological restoration study such as this one, as HEP does not differentiate between Habitat Units (HUs) of a common species and HUs of a rare species, nor between the value of common and scarce habitats. Nor does it consider the ecological role of a species or habitat outside of the project site itself, that is, in the local or regional context.

In the case of the Hamilton wetland restoration study, the FWS HEP shows relatively small overall gains in HUs from using dredged material to accelerate the rate of marsh formation. This is because as tidal marsh develops, it replaces mudflats which themselves have habitat value. Accelerating the rate of tidal marsh development merely accelerates the rate at which this tradeoff occurs, yielding little increase in total habitat units.

For this reason, the standard incremental mitigation analysis for this study has been modified to instead measure the cost-effectiveness of project increments in creating tidal salt marsh and related habitats. Tidal marsh habitat is of particular concern in the San Francisco Estuary (San Francisco, San Pablo, and Suisun Bays) due to the magnitude of historic losses of this habitat type, the high ecological value of this habitat, and its particular importance to endangered species (the California clapper rail and the salt marsh harvest mouse).

To evaluate the habitat benefits of using dredged material, the 12 evaluation species/habitat combinations used in the FWS HEP were narrowed down to 4 combinations: salt marsh rail guild/tidal salt marsh; egret guild/tidal salt marsh; wintering mallard/tidal pond; and wintering mallard/tidal panne. These are the species/habitat combinations within the HEP that would particularly benefit from tidal marsh restoration. Limiting the analysis to these combinations allows the cost-effectiveness and cost-efficiency of the alternatives in creating *tidal marsh habitat* to be determined.

The exclusion of the other species/habitat combinations was made knowing that some of them would experience net losses. However, trading off these species and their habitats for species and habitats deemed much more important has been endorsed (within certain limits) by the non-federal sponsor and the resource agencies, and in fact is an unavoidable consequence of implementing any of the action alternatives.

Table 4.5 compares the results from the FWS HEP and the modified HEP. The FWS HEP shows similar results for the four action alternatives, with Alternative 3 producing slightly more (and Alternative 4 producing slightly fewer) habitat units than alternatives 2 and 5. In contrast, the modified HEP shows alternatives that restore tidal marsh on both parcels (4 and 5) producing larger habitat gains than alternatives that only use the HAAF parcel (2 and 3), and alternatives using dredged material (3 and 5) producing larger habitat gains than their counterparts that do not use dredged material (2 and 4).

TABLE 4.5
COMPARISON OF THE FWS HEP AND THE MODIFIED HEP

Alternative	Fish and Wildlife Service HEP Results: Net Gains	Modified HEP Results: Net Gains
2	176.16	158.98
3	186.22	206.16
4	163.13	241.13
5	175.00	303.91

The modified HEP will be used in the incremental analysis because it specifically measures one of the project's intended outputs, tidal marsh habitat. The FWS HEP is included here for purposes of comparison only.

4.3.2 Cost Effectiveness/Incremental Cost Analysis

While there is no generally accepted method for quantifying environmental benefits in monetary terms, two decision making tools have helped planners decide how to allocate limited resources more effectively and determine which plans are economically irrational. *Cost effectiveness* analysis helps filter out plans with equivalent output levels that are more expensive. *Incremental analysis* allows planners to progressively proceed through available levels of output and asks if the next level of additional outputs is worth its additional cost.

For the Hamilton Wetlands Restoration study, potential increments were identified for consideration in the incremental analysis. These increments consist of various combinations of wetland restoration on one or both parcels, and with or without dredged material. The project costs, outputs, incremental costs, incremental costs and incremental costs per habitat unit (HU) were then assembled into a spreadsheet for each alternative. Finally, the combination of increments were evaluated incrementally and it was determined whether each additional increment was economically justified.

The combinations of increments considered for the analysis are:

a.) No Action Plan
b.) The State Lands Commission parcel without dredged material
c.) Alternative 2 (the Hamilton Army Airfield parcel without dredged material)
d.) Alternative 3 (the Hamilton Army Airfield parcel with dredged material)
e.) The State Lands Commission parcel with dredged material
f.) Alternative 4 (both parcels without dredged material)
g.) Alternative 5 (both parcels with dredged material)
h.) The State Lands Commission parcel without dredged material and the Hamilton Army Airfield parcel with dredged material
i.) The State Lands Commission parcel with dredged material and Hamilton Army Airfield parcel without dredged material

The following tables 4.5 through 4.8 trace the progression of the most cost-effective combination of increments through a series of efficiency filters. Each inefficient solution was discarded until only the most cost efficient combinations remain.

Each iteration uses the prior filter's most efficient combination as the new base from which the next most efficient combination will be determined. In the first iteration the No Action Plan is the base combination against which all of the other combinations will be compared. The incremental change in output and cost is calculated for each combination while the non-economically efficient combinations were discarded. The most economically efficient combination forms the baseline of the next iterations. The "SLC parcel without dredged material" combination represents the first iteration's most efficient combination and thus forms the baseline for the next iteration. Note that since the "HAAF without and SLC with dredged material" combination provides greater outputs at lower cost than Alternative 3, the latter was removed from the series. Table 4.6 presents a tabular analysis of the first iteration.

Table 4.6
Incremental Cost/Cost Efficiency Analysis
First Iteration

Alternative	Cost	Incremental Cost	Output	Incremental Output	Incremental Cost/Output
No Action	$0	---	0	---	---
SLC parcel only w/o dredged material	**$5,426,604**	**$5,426,604**	**4,600**	**4,600**	**$1,180**
SLC parcel only w/ dredged material	$15,250,195	$15,250,195	5,474	5,474	$2,786
Alternative 2 only w/o dredged material	$15,254,210	$15,254,210	8,903	8,903	$1,713
Alternative 4 w/o dredged material	$20,680,814	$20,680,814	13,503	13,503	$1,532
HAAF w/o & SLC w/ dredged material	$30,504,405	$30,504,405	14,377	14,377	$2,122
~~**Alternative 3 only w/ dredged material**~~	~~**$40,033,016**~~	~~**$40,033,016**~~	~~**11,545**~~	~~**11,545**~~	~~**$3,468**~~
SLC w/o & HAAF w/ dredged material	$45,459,620	$45,459,620	16,145	16,145	$2,816
Alternative 5 w/ dredged material	$55,283,211	$55,283,211	17,019	17,019	$3,248

The second iteration repeats the selection process with the inefficient combination being excluded. In the second iteration, the next economically efficient combination, Alternative 4, is highlighted. With an incremental cost per output of $1,713, it is the most efficient of the remaining plans. In other words, this plan provides an additional 8,903 HUs at a cost of $1,713 each. The inefficient combinations, "SLC parcel with dredged material" and Alternative 2 were also identified so that they could be excluded from the third iteration. Table 4.7 highlights the selection process for the second iteration.

Table 4.7
Incremental Cost/Cost Efficiency Analysis
Second Iteration

Alternative	Cost	Incremental Cost	Output	Incremental Output	Incremental Cost/Output
No Action	$0	---	0	---	---
SLC parcel only w/o dredged material	$5,426,604	$5,426,604	4,600	4,600	$1,180
~~SLC parcel only w/ dredged material~~	~~$15,250,195~~	~~$9,823,591~~	~~5,474~~	~~874~~	~~$11,240~~
~~Alternative 2 only w/o dredged material~~	~~$15,254,210~~	~~$9,827,606~~	~~8,903~~	~~4,303~~	~~$2,284~~
Alternative 4 w/o dredged material	**$20,680,814**	**$15,254,210**	**13,503**	**8,903**	**$1,713**
HAAF w/o & SLC w/ dredged material	$30,504,405	$25,077,801	14,377	9,777	$2,565
SLC w/o & HAAF w/ dredged material	$45,459,620	$40,033,016	16,145	11,545	$3,468
Alternative 5 w/ dredged material	$55,283,211	$49,856,607	17,019	12,419	$4,015

Table 4.8 presents the third iteration with the "SLC without and HAAF with dredged material" combination being identified as the next larger cost-efficient combination.

Table 4.8
Incremental Cost/Cost Efficiency Analysis
Third Iteration

Alternative	Cost	Incremental Cost	Output	Incremental Output	Incremental Cost/Output
No Action	$0	---	-	---	---
SLC parcel only w/o dredged material	$5,426,604	$5,426,604	4,600	4,600	$1,180
Alternative 4 w/o dredged material	$20,680,814	$15,254,210	13,503	8,903	$1,713
~~HAAF w/o & SLC w/ dredged material~~	~~$30,504,405~~	~~$9,823,591~~	~~14,377~~	~~874~~	~~$11,240~~
SLC w/o & HAAF w/ dredged material	**$45,459,620**	**$24,778,806**	**16,145**	**2,642**	**$9,379**
Alternative 5 w/ dredged material	$55,283,211	$34,602,397	17,019	3,516	$9,841

The fourth and final iteration identifies Alternative 5 as the next most cost-efficient combination. Thus, the order and combination in assembled order of cost and outputs are follows: No Action, SLC parcel only without dredged material, Alternative 4, SLC without and HAAF with dredged material and Alternative 5.

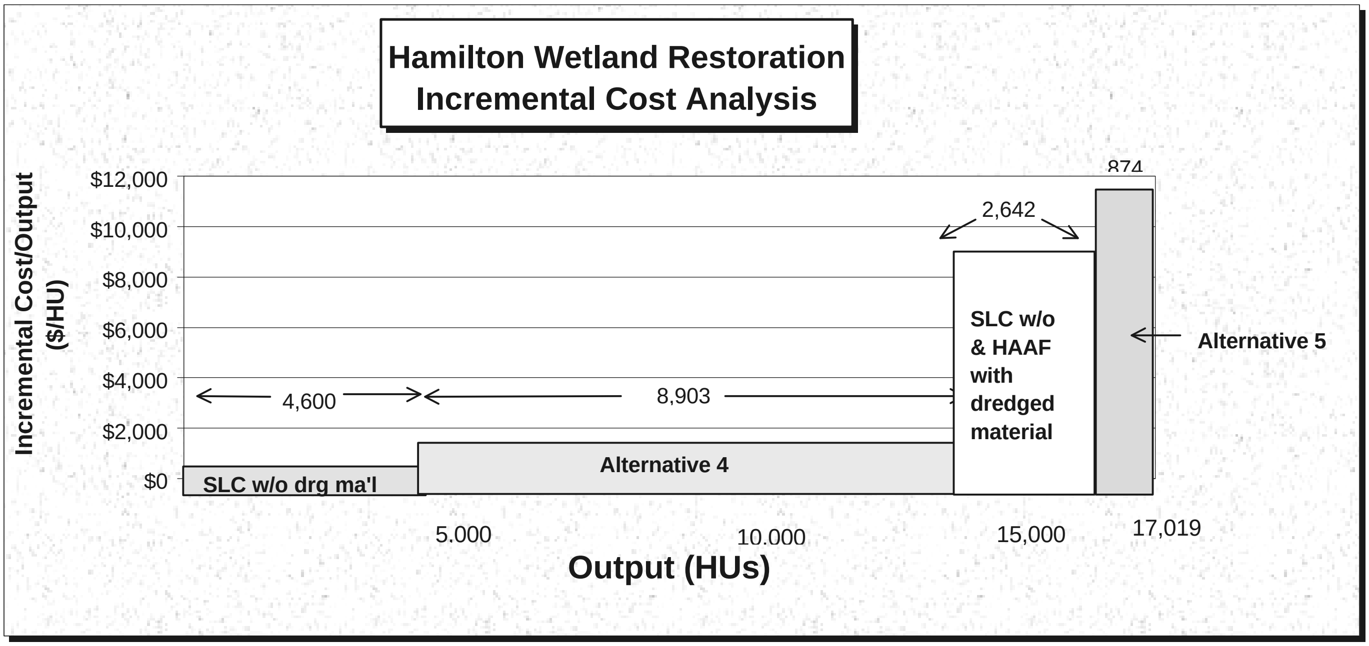
Table 4.9
Incremental Cost/Cost Efficiency Analysis
Fourth Iteration

Alternative	Cost	Incremental Cost	Output	Incremental Output	Incremental Cost/Output
No Action	$0	—	-	—	—
SLC parcel only w/o dredged material	$5,426,604	$5,426,604	4,600	4,600	$1,180
Alternative 4 w/o dredged material	$20,680,814	$15,254,210	13,503	8,903	$1,713
SLC w/o & HAAF w/ dredged material	$45,459,620	$24,778,806	16,145	2,642	$9,379
Alternative 5 w/ dredged material	**$55,283,211**	**$9,823,591**	**17,019**	**874**	**$11,240**

The following Figure 4.3 demonstrates the questioning process, i.e., if the next level of output is "worth it". Abrupt changes in the incremental cost curve, often referred to as a breakpoint, a spike, or a jump, occur where an incremental cost increases relatively sharply in contrast to preceding or following incremental costs. The findings reveal that Alternatives 2 and 3 are not cost effective, evidenced by their removal from analysis. Likewise, Alternatives 4 and 5 are the most cost effective given their outputs.

In a typical incremental analysis of this type, the decision-maker would then need to decide whether the additional $11,240 incremental cost per habitat unit of alternative 5 is justified. However, for this study this decision is complicated by the additional output of this increment, namely its provision of additional upland dredged material disposal capacity. This issue will be revisited and the tradeoffs examined in Sections 4.4 and 4.5 below.

Figure 4.3



4.3.3 Relationship of the Incremental Analysis Conclusions to the Study Alternatives

The incremental analysis determined that four increments are most cost-efficient for their level of output of tidal marsh habitat. The other four increments, including Alternatives 2 and 3, were determined to not be cost-efficient for this output. However, other criteria are used in evaluating and screening potential alternatives and are applied here to the increments considered.

The lowest cost-efficient increment retained in the analysis is the State Lands Commission (SLC) parcel with no placement of dredged material. However, this increment does not effectively address the study objectives of (1) wetland restoration on the HAAF parcel, (2) reduction of aquatic disposal impacts through reuse of dredged material, and (3) facilitating the base closure process. Therefore, this increment was not considered in the feasibility study.

The third cost-efficient increment retained in the analysis consists of the HAAF parcel with dredged material placement and the SLC parcel without dredged material placement. This increment is modestly more cost-efficient at producing tidal marsh habitat units than alternative 5, but would produce those units more slowly and is considerably less effective at addressing upland disposal goals.

Alternative 2 was determined to not be cost-efficient in producing tidal marsh habitat relative to other increments, but was retained for analysis because it is the lowest-cost alternative that addresses the wetland restoration and base-closure objective of the study. Alternative 3 was also determined to not be cost-efficient in producing tidal marsh habitat, but it effectively addresses the study goals of reuse of dredged material and facilitating base closure. It was therefore retained for consideration in the feasibility study.

4.4 Associated Evaluation Criteria

4.4.1 Completeness

All the action alternatives are complete conceptual tidal marsh restoration plans. None of these alternatives require any additional substantial features to accomplish the study objectives.

4.4.2 Effectiveness

Habitat Restoration

Tidal salt marsh and endangered species habitat: All the action alternatives are effective to varying degrees in restoring tidal salt marsh habitat and its value for endangered species. Alternative 5 is the most effective, as it restores more of these habitats than Alternatives 2 and 3, and restores these habitats in less time than Alternative 4 (as shown in Figure 4.4). Alternatives 3 and 4 are intermediate in effectiveness, with Alternative 3 restoring less habitat, but more quickly, while Alternative 4 restores more habitat but over a longer period. Alternative 2 is the least effective in producing tidal marsh and endangered species habitats. The no-action alternative is not effective in increasing these habitats.

Natural Gradient: Alternatives 3 and 5 would provide a gradual natural gradient between upland and seasonal wetland habitats in the panhandle area and the tidal habitats in the main part of the site, which would have several advantages. First, the gradual habitat transition would provide better wildlife habitat by providing more habitat diversity and easier wildlife dispersal and migration. Second, this gradual transition would enable the project habitats to better adapt to changing conditions in the future. For example, if sea level rises, habitats in this part of the site will be able to gradually migrate uphill in response to this change. Third, operations and maintenance costs would be reduced due to the entire site draining naturally, without need for gated culverts and a cross-panhandle levee.

Base Closure

All the action alternatives are effective in achieving the goals of the Hamilton reuse plan and the BRAC process. The no-action alternative is not effective in achieving the goals of these plans because it does not restore wetlands or resolve the future of these parcels.

Beneficial Reuse of Dredged Material

Alternatives 3 and 5 are effective in achieving the objective of beneficial reuse of dredged material, with Alternative 5 being more effective because it provides more upland disposal capacity. The no-action alternative and Alternatives 2 and 4 are not effective in furthering this objective because they do not provide for upland disposal of dredged material.

Overall Effectiveness

Alternative 5 is most effective overall in achieving the three study objectives of wetland restoration (including endangered species habitat restoration), base closure, and beneficial reuse of dredged material.

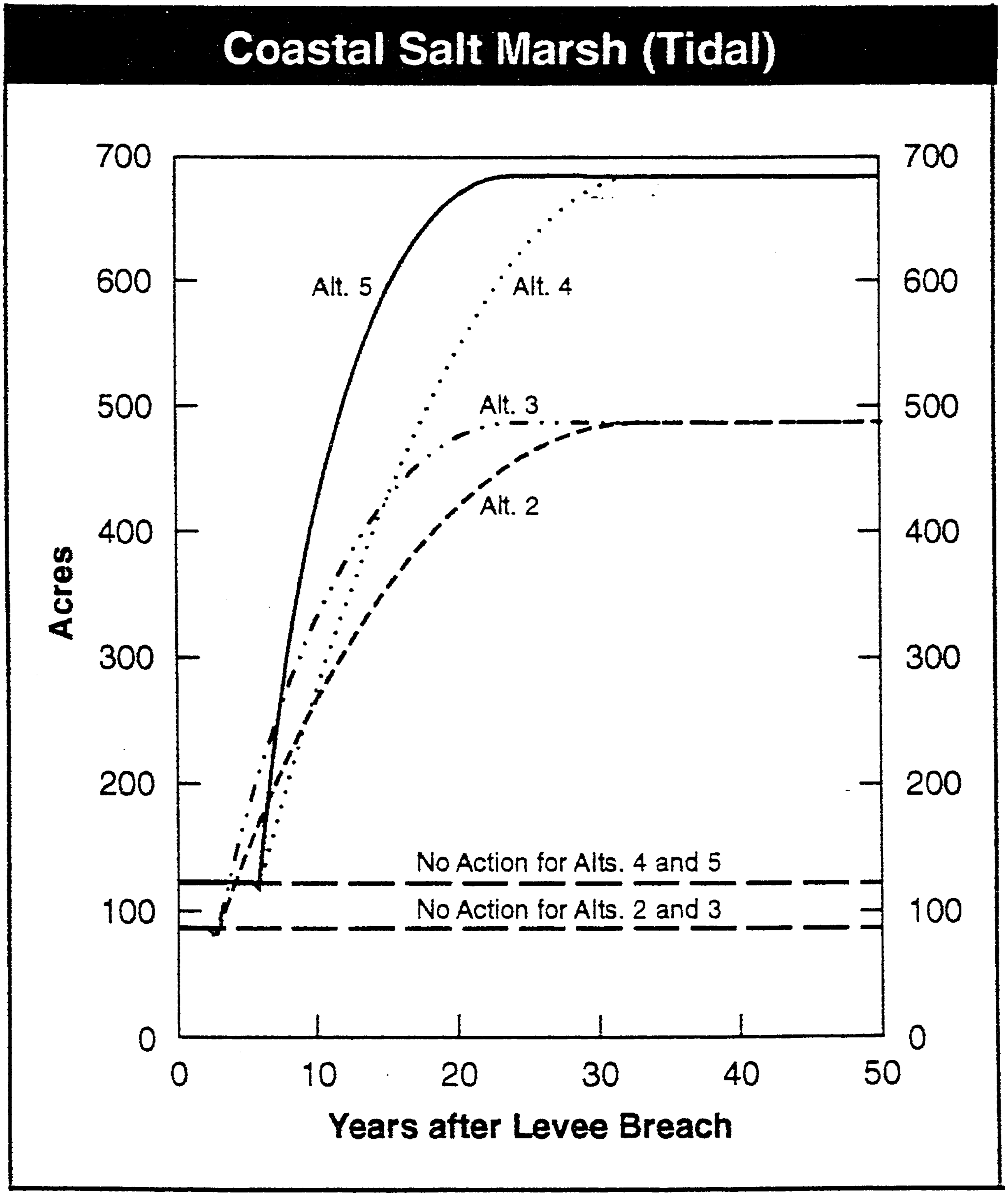


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Figure
Habitat Acreages at Levee Breach and 50 Years after Levee Breach

4.4.3 Efficiency

Efficiency can be examined in several different ways for this project. Economic efficiency measures the amount of project outputs (such as habitat units, acres of tidal marsh, or upland dredged material disposal capacity) per unit of economic cost. Ecological efficiency measures the amount of project output per unit of ecological input.

Economic Efficiency

As explained above in the incremental analysis, the most economically efficient study alternative in terms of creation of tidal marsh habitat units is Alternative 4, with an incremental cost of $1,532 per habitat unit over the No-Action Plan. Alternatives 2 and 3 are not cost-efficient for their levels of habitat output; Alternative 2 has a relatively low average cost per habitat unit of $1,713, while Alternative 3 has an average cost per habitat unit of $3,168. Alternative 5 has a high incremental cost, but is cost-efficient for its level of output and has an average cost per habitat unit of $3,248.

Alternative 5 is slightly more economically efficient at providing dredged material disposal capacity than Alternative 3, with a cost per cubic yard of $5.17 vs. $5.64 for alternative 3 (incremental cost over ocean disposal). Both these alternatives provide disposal of dredged material at a lower cost than at the Sonoma Baylands project or the proposed Montezuma Wetlands project. Alternatives 2 and 4 and the no-action alternative do not provide dredged material disposal capacity. Alternative 5 is therefore more efficient at meeting the objective of providing capacity for upland disposal of dredged material, as stated in the LTMS program and other plans, as it provides the greatest total upland disposal capacity and the lowest unit cost for upland disposal.

Alternative 3 is not cost-efficient for its level of *habitat* output, and Alternative 5 has the highest incremental cost for creation of additional tidal marsh habitat units. However, these alternatives provide for the upland disposal of dredged material in a cost-efficient manner. The cost-efficient disposal of dredged material created by using dredged material in these alternatives can be viewed as a free benefit of accelerated wetland restoration. Therefore, considering both tidal marsh habitat creation and dredged material reuse, Alternatives 3 and 5 can be considered to be quite economically efficient.

Ecological Efficiency

Ecological efficiency is harder to quantify. One way to measure it is to measure the amount of desired habitat value created per acre of habitat created. Since tidal marsh is the primary habitat objective of this project, Table 4.10 shows the output of tidal marsh habitat units per acre of tidal marsh created. This table shows that alternatives using dredged material produce more tidal marsh habitat value (over the 50-year evaluation period) per acre of tidal marsh ultimately created. This result is expected since the HEP assumes that tidal marsh would form faster with the use of dredged material.

All the action alternatives would increase the total amount of habitat on the site by converting currently developed areas to wildlife habitat. These alternatives would also replace common grassland habitat with scarce tidal marsh habitat, while retaining existing non-tidal wetland habitat values and enhancing endangered species habitat values. In this sense, all the alternatives are ecologically efficient, especially Alternatives 4 and 5 as they produce these results to a greater degree.

TABLE 4.10
COMPARATIVE ECOLOGICAL EFFICIENCY
OF THE STUDY ALTERNATIVES

Alternative	*Tidal Marsh Gain (Habitat Units)*	*Total Acres of Tidal Marsh Created*	*Tidal Marsh Habitat Value Gain Per Acre*
2	8,903	392	22.71
3	11,545	397	29.08
4	13,503	578	23.36
5	17,019	570	29.86

Notes: Habitat gains are in total habitat units over a 56-year period. Acreage figures are from the U.S. Fish and Wildlife Service HEP and are approximate.

The no-action alternative maintains existing habitats but fails to restore valuable habitats that have suffered severe historic losses and which provide endangered species habitat. As this alternative would create neither ecological losses nor ecological gains, it can not be considered to be ecologically efficient or inefficient. Nonetheless, it represents a lost opportunity for improving environmental quality.

Overall Efficiency
In terms of average costs, alternative 4 is most cost-efficient at producing tidal marsh habitat, with Alternatives 4 and 5 being efficient for their level of output. Alternatives 3 and 5 have similar cost-efficiencies for dredged material disposal. While they are less efficient (in terms of marginal economic costs) in producing tidal marsh habitat than the other alternatives, their combined efficiency in producing upland disposal of dredged material and tidal marsh habitat is high.

4.4.4 Acceptability

All the action alternatives are acceptable to the non-federal sponsor, local agencies, and the resources agencies, provided that concerns over such issues as drainage, flood control, and levee stability are adequately addressed. The non-federal sponsor prefers Alternative 5. Table 4.11 shows the responsiveness of the alternatives to various local, regional, and federal plans. Alternative 5 is the most responsive to these plans because it provides the maximum wetland restoration, the maximum beneficial reuse of dredged material, and maintains both the HAAF and SLC parcels as open space.

Table 4.11
Responsiveness of the Study Alternatives to Local, Regional and Federal Plans

	Alternatives				
Plan/Agency	***1***	***2***	***3***	***4***	***5***
San Francisco Bay Plan / S.F. Bay Conservation and Development Commission	L	M	M	M	H
General Plan / City of Novato	L	M	M	H	H
Hamilton Reuse Plan and BRAC / Department of Defense	L	H	H	H	H
Draft S.F. Estuary Ecosystem Goals Report / Interagency Project	L	M	M	H	H
S.F. Estuary Comprehensive Conservation and Management Plan / S.F. Estuary Project	L	M	M	M	H
Long-Term Management Strategy / Interagency Program	L	L	M	L	H
Ecosystem Restoration Program Plan / CALFED	L	M	M	M	H
Oakland Harbor Navigation Improvement / Corps of Engineers and Port of Oakland	L	L	H	L	H

L = low   M = medium   H = high

4.5 Tradeoff Analysis

4.5.1 Display of Relative Rankings

The five alternatives were assigned relative rankings indicating how well they would address the study objectives and selected evaluation criteria. A ranking of 1 indicates that the alternative best satisfies that objective or criterion. Economic efficiency ratings were determined using average rather than marginal economic costs. Ecological efficiency was not included due to important qualitative considerations. The rankings are displayed in Table 4.12. Note that in some cases alternatives were tied in their rankings.

4.5.2 Tradeoffs between Alternatives

Tidal Marsh
Alternatives 4 and 5, which use both parcels of land, would create much more tidal marsh habitat than Alternatives 2 and 3, which would only use the HAAF parcel. Alternatives 3 and 5 would create tidal marsh habitat more quickly than Alternatives 2 and 4, respectively. By creating a natural gradient, Alternatives 3 and 5 would also create habitats with higher value for wildlife and more ability to adapt to changing conditions. Overall, Alternative 5 would create the largest amount of tidal marsh habitat value, and would create a larger amount of this habitat value sooner than the other alternatives. Therefore, it best meets this study objective.

Table 4.12
Relative Rankings of the Study Alternatives
by Study Objectives and Evaluation Criteria

Objective or criterion	**Alternatives**				
	1	***2***	***3***	***4***	***5***
Wetland Restoration					
Endangered species	5	4	3	2	1
Creation of tidal marsh habitat value	5	4	3	2	1
Beneficial Reuse of Dredged Material					
Upland dredged material disposal	3	3	2	3	1
Base Closure					
Hamilton Reuse Plan/BRAC	5	1	1	1	1
Other considerations					
Economic efficiency- tidal marsh	-	2	3	1	4
Economic efficiency- dredged material	-	-	2	-	1
Acceptability	5	4	2	2	1

Endangered Species Habitat
Alternatives 3 and 5 would also provide substantial amounts of endangered species habitat approximately 10 years faster than under Alternatives 2 and 4. The two endangered species of particular concern here, the California clapper rail and the salt marsh harvest mouse, only occur around the San Francisco Estuary. These species have lost the vast majority of their habitat, and the clapper rail in particular is close to extinction. Provision of additional habitat for these species is considered to be very important by the resource agencies. Considerably accelerating the creation of this additional habitat would be a major benefit of Alternatives 3 and 5. Alternative 5 would provide more endangered species habitat value than the other alternatives.

Beneficial Reuse of Dredged Material
Alternatives 3 and 5, which would use dredged material, would cost far more than their counterparts 2 and 4 which use only natural sedimentation. Using dredged material to accelerate the creation of tidal marsh habitat provides less efficient increases in tidal wetland habitat units, while providing substantial upland disposal for dredged material in an efficient manner. However, Alternatives 3 and 5 would also avoid the environmental impacts of disposing of dredged material in an aquatic environment. Alternative 5 would maximize the beneficial reuse of dredged material, so best meets this study objective.

Summary
Given all these considerations, Alternative 5 best addresses the study objectives of tidal marsh restoration, beneficial reuse of dredged material, and implementation of base closure. Alternative 5 also best addresses the other evaluation criteria of completeness, effectiveness, efficiency, and acceptability, while minimizing ongoing management. Therefore, it is selected as the preferred plan.